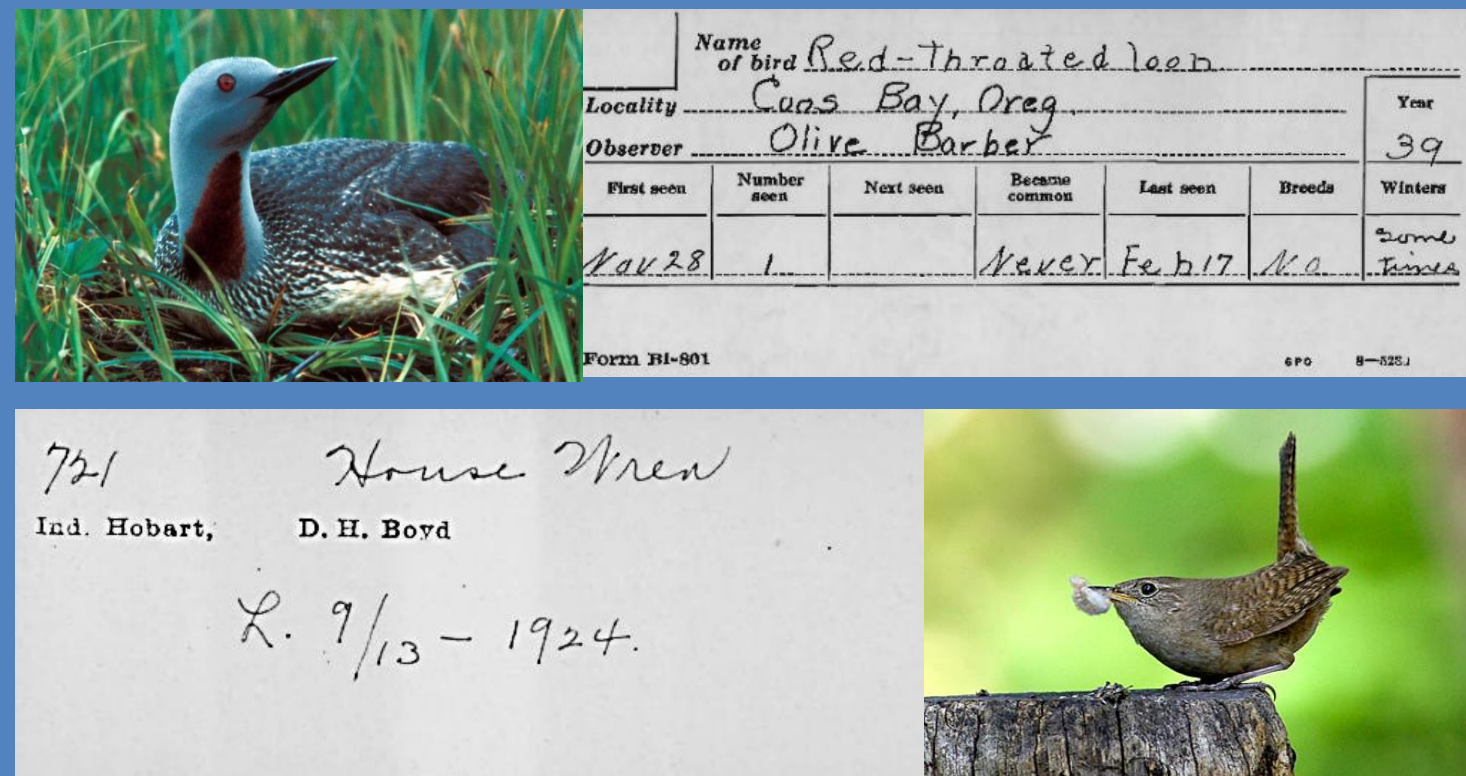


NORTH AMERICAN BIRD PHENOLOGY PROGRAM: Illuminating Shifting Migratory Bird Patterns Using A Legacy Citizen Science Project

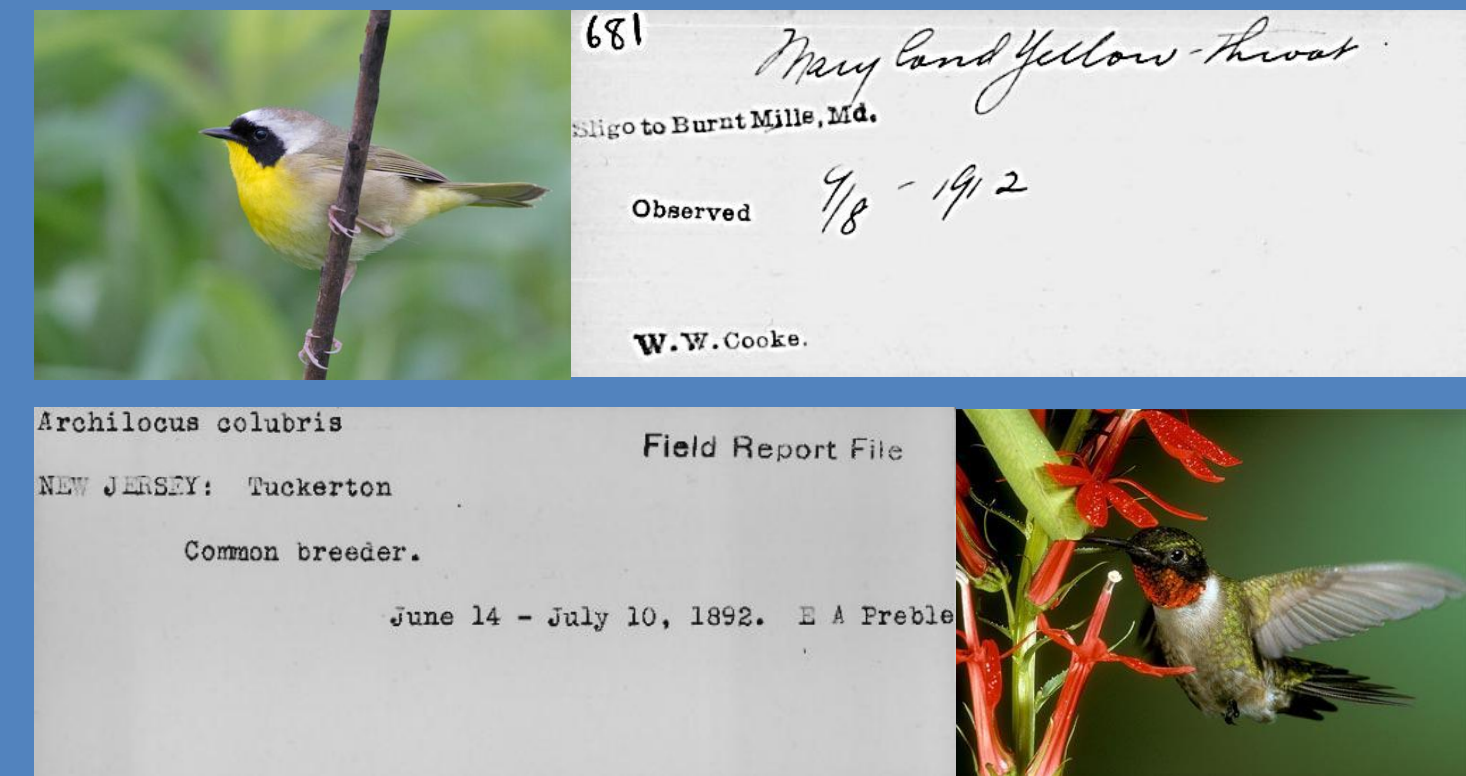
Jessica Zelt, Jason Courter, Ali Arab, Ron Johnson, and Sam Droege

Abstract

Over the past four years, the North American Bird Phenology Program (NABPP) has revived a legacy dataset of first arrival dates, maximum abundance, and departure dates of migratory birds across North America. This historic program, active between 1880 and 1970, was coordinated by the Department of the Interior and sponsored by the American Ornithologists' Union. With a growing network of over 2,500 volunteers worldwide, records are being transcribed online and made freely accessible to the public, researchers and policy makers. The NABPP was established in response to questions about changes in climate around the globe and the need to understand the wide-scale effects on bird migration. With this collection, we have established a historical baseline of bird arrival dates to compare with recently collected data. Understanding long-term changes in spring migration arrival dates in birds can provide an important indicator of reproductive success and therefore population stability. Here, we present two case studies illustrating how data from the North American Bird Phenology Program have been used to model historical Ruby-throated Hummingbird (*Archilochus colubris*) and Purple Martin (*Progne subis*) arrival dates in eastern North America.



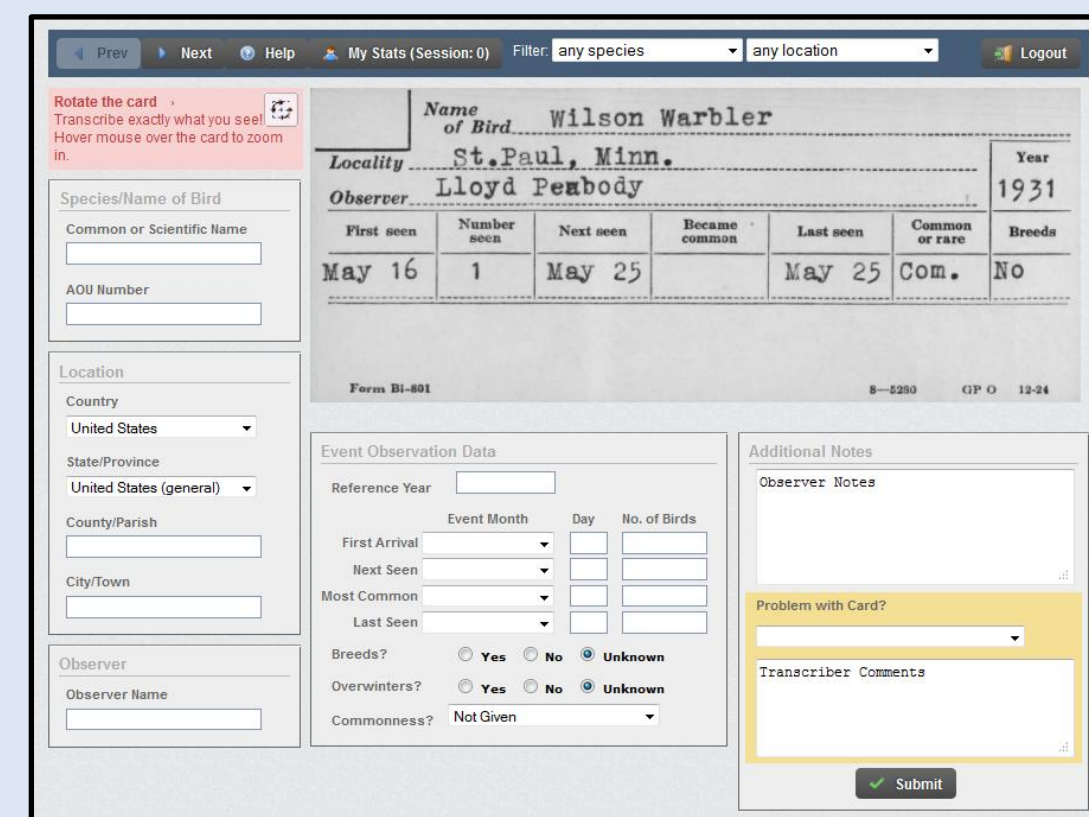
To learn more, get involved, or download data,
go to:
<http://www.pwrc.usgs.gov/bpp/>



Photographs courtesy of: <http://www.danandphotography.com>, <http://www.kaydandphotography.com>, and <http://jogtaturegarden.org>



SCANNING THE MIGRATION CARDS



CONVERTING THE CARD INTO AN IMAGE



TRANSCRIBING THE DATA

Observation ID	Species_ID	ADU	Observer	Country	State/Province	Town	Year	First Arrival Dt	First Arrival Nb	Most Common Dt	Last Seen Dt
183308	cherryey swt	7	neal	US	42	new hope	1901	24-May		23-May	23-May
183309		7	neal	US	0	new hope	1901	24-May		23-May	23-May
222945		695	G. MacFarland	US	25	Melrose	1901	24-May		23-May	23-May
276643	Black-throated Blue Warbler		E.C. Vieles	US	42	Durham	1901	24-May		23-May	23-May
173449	Black-bellied Cuckoo		E.C. Vieles	US	33	Saraborn	1901	24-May		23-May	23-May
193739	Selasphorus rufus		Smith	US	35	Virginia	1905	18-Jun			23-Jun
193739		420	Smith	US	35	Virginia	1905	18-Jun			23-Jun
171436	Black-bellied Cuckoo		John J. Schaller	US	17	Port Byron	1905	4-May		5-May	
225588	Yellow Warbler		Agnes Bowers	US	35	Massville	1905	12-May		15-May	
193493	Cheney Swift		H. Kugel	US	55	Racine	1905	4-May		5-May	16-May
188551	Cheney Swift		W.H. Kugel	US	34	Plankfield	1901	16-May		15-May	
21967	Osprey		Glen V. Chamberlain	US	23	Piquetville	1903	30-Apr			
28525		654	Todd	US	42	Beaver	1901	7-May			17-May
286923	Black-throated Blue Warbler		Fairbank Museum	US	50	St. Johnsbury	1900	7-Dec			
230215	Long-eared Owl		Elton	CA	8	Plover Mills	1900	7-Dec			
276703	Black-throated Blue Warbler		L. R. Velle	US	35	Plantburg	1903	17-May			
193470	Purple Martin		H.C. Oberholser	US	22	Caddo Lake	1903	19-Jun		13	
207794	Black Throated Blue Warbler		C.C. Watson	UK	H8	Tonawank	1901	4-May		8-May	20-May
176872	Common Loon		F.C. Seymour	US	55	Tonawank	1900	27-Apr			
203285	Nighthawk		Margaret E. Morse	US	39	Cleveland	1942	14-May		12-May	14-May
204872	Howell Nighthawk		Talbot F. Smith	US	48	Vacoas	1931	7-May			
190413	Cheney Swift		J.E. Silwell	US	48	Dallas Region	1936	5-Apr			
176343	Common Loon		F.M. Watson	US	12	Pasadena	1949-1950	27-Oct			
207253		654	Cass	US	9	Hartford	1913	6-May		9-May	26-May

RELEASING THE DATA

To date, over 1.2 million original migration records, dating between 1880-1970, for over 870 species, have been scanned by volunteers in the BPP Office.

All of the scanned migration cards are converted into png images and uploaded to the BPP website.

A world wide network of over 2,500 volunteers transcribe the bird migration records online. Two individuals transcribe each migration card and the data from those two transcriptions are compared. If they match, the data is sent into the BPP final database, if it does not match, it is sent to a third volunteer for transcription.

Once transcriptions are complete, the data is compiled in a database for analysis. All data will be released publicly on the BPP website for free download to the scientific community and public.

Case Study 1: Ruby-throated Hummingbirds

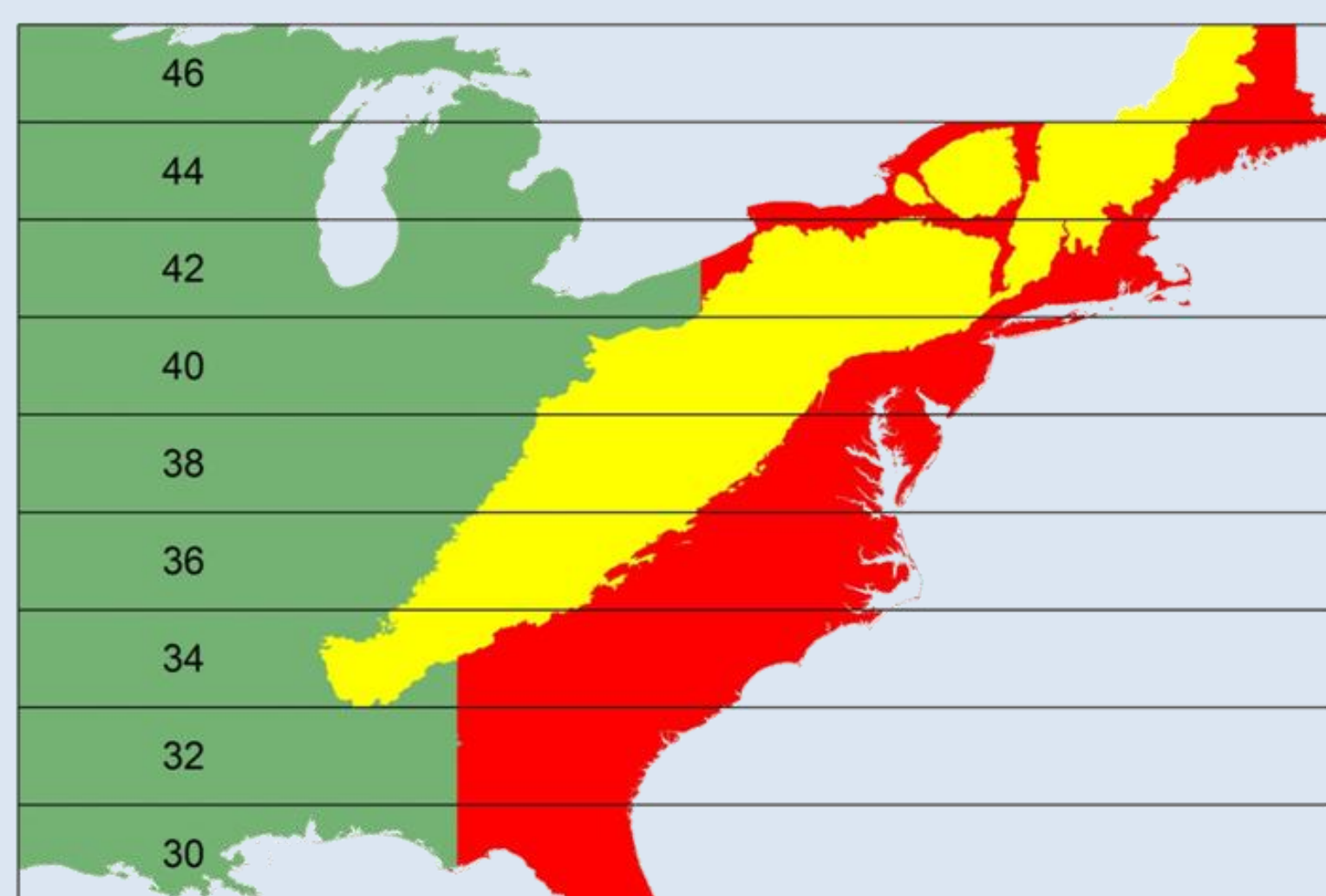


Fig. 1. Our study area (29-47°N, 67-95°W) divided into three regions based on classifications used by the Breeding Bird Survey (www.pwrc.usgs.gov/bbs) and the Environmental Protection Agency (Level III Ecoregions; http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm).

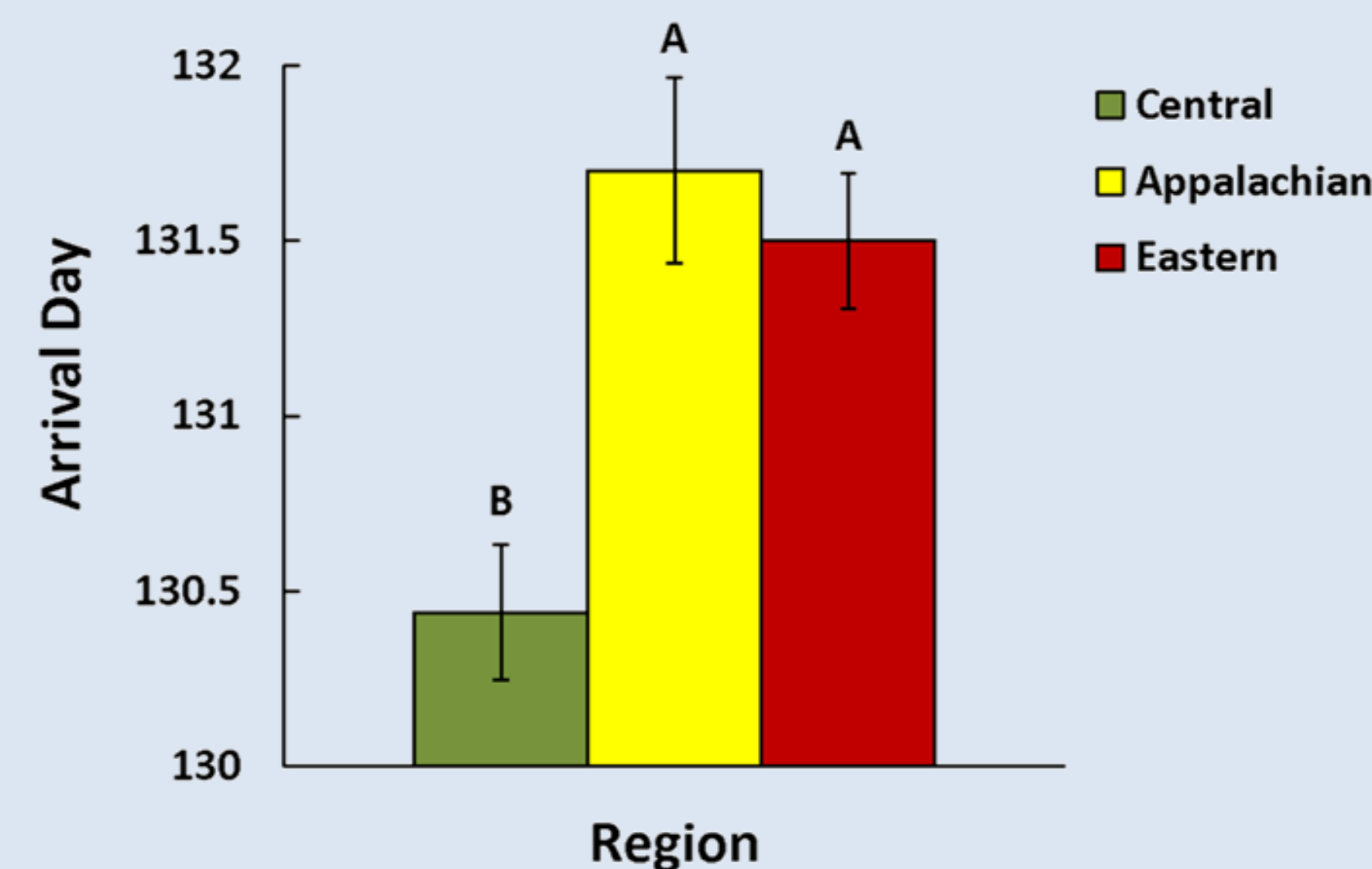


Fig. 2. Difference in mean first arrival dates (± S.E.) of Ruby-throated Hummingbirds in the Central (N = 2002), Appalachian (N = 1075), and Eastern Regions (N = 1988; see Fig. 1 for region designations). Arrival days are expressed in 'day of year' and corrected for leap years; for example, '130' corresponds to May 10. Inset letters represent differences that are significant at the P < 0.05 level.

Objective:

- To demonstrate how data from the recently revitalized North American Bird Phenology Program (BPP) can be used to generate an historical understanding of migration in Ruby-throated Hummingbirds.

Methods:

- Transcribed hummingbird arrival records (N = 5,065) from BPP data
- Assigned each arrival a location (i.e., latitude, longitude, and altitude) based on the centroid of the reported arrival city using the GPS visualizer geocoding service (www.gpsvisualizer.com)
- Assessed the effects of latitude, longitude, and altitude on hummingbird arrival dates using multiple regression
- Compared differences in arrivals by region using ANOVA, while including latitude as a covariate

Results and Discussion:

- From 1880-1969, hummingbirds arrived 3.4 days later for every 1° increase in latitude, 1.2 days later for every 10° longitude moving from west to east, and 7.5 days later for every 1000 m increase in elevation.
- Mean arrival dates differed by region (Fig. 2), with birds arriving earlier in the central U.S. than in the Appalachian Region and Eastern Regions.
- Earlier arrivals in the central United States possibly explained by a difference in travel distance, with central migrants travelling directly north from Gulf States where many hummingbirds make landfall and eastern migrants travelling northeast.
- If more central migrants migrate over land (i.e., Mexico and Texas), perhaps less time is needed to refuel than for their eastern counterparts that make dangerous and exhausting trips across the Gulf of Mexico.
- Important to consider spatial variables such as altitude and region in phenology studies.
- Our results provide an important historical baseline to compare recent arrivals with to assess the impacts of climate change.

For more information, please contact Dr. Jason Courter or Dr. Ron Johnson, Wildlife Ecologist, at Clemson University (jcourte@clemson.edu; ronj@clemson.edu).

Case Study 2: Purple Martins

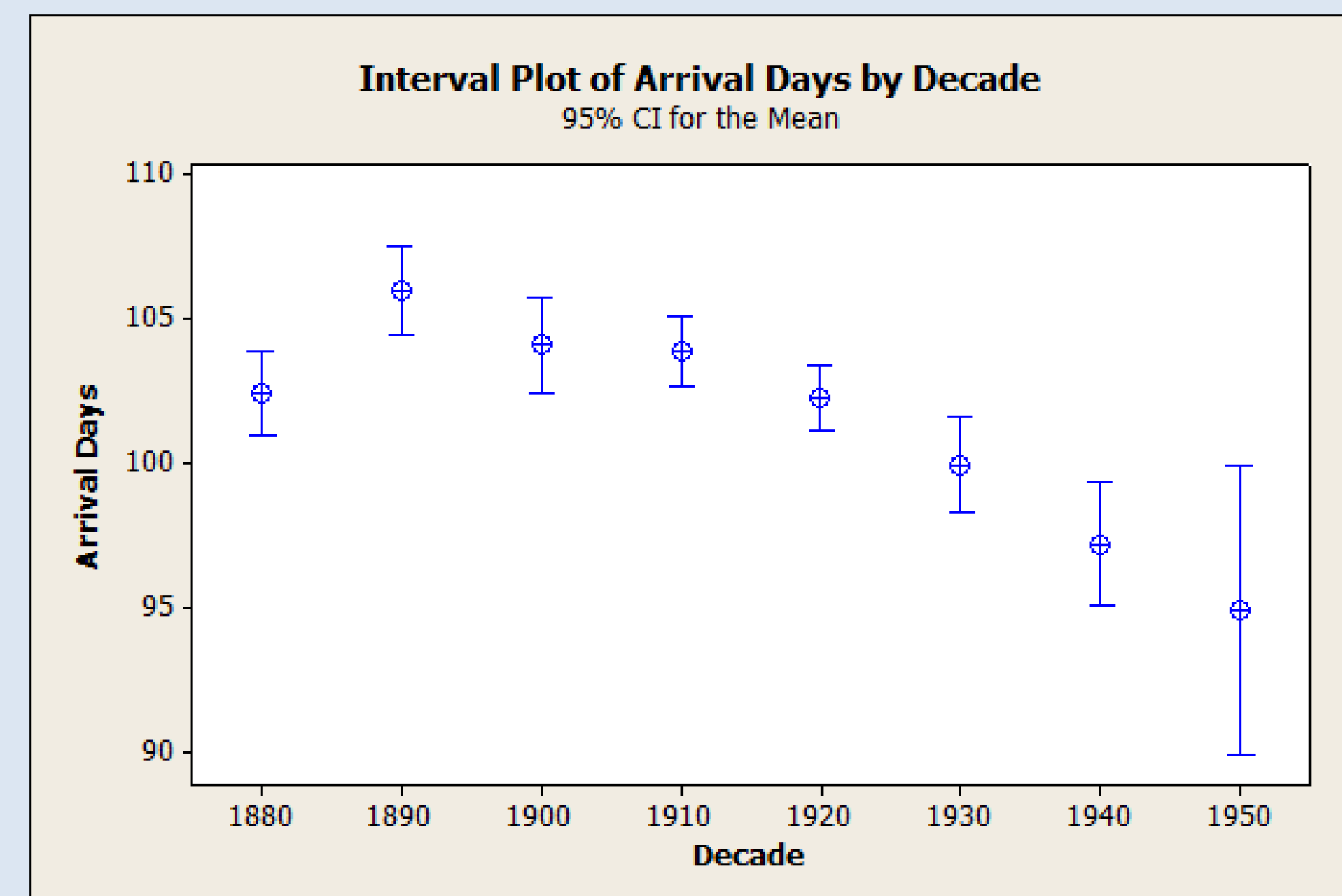


Fig. 3. Interval plot for the mean arrival days for decades 1880-1950. Intervals show the 95% confidence interval for the mean decadal arrival dates. Arrival days are expressed in 'day of year' and corrected for leap years; for example, '90' corresponds to March 29. Sample sizes for decades are 501 (1880s), 565 (1890s), 700 (1900s), 1126 (1910s), 1152 (1920s), 738 (1930s), 444 (1940s), 119 (1950s).

It should be noted that the relatively large standard error for the 1950's data in Figure 3 is due to relatively lower sample size (119 observations) than the previous decades.

For more information, please contact Ali Arab at Georgetown University (aa577@georgetown.edu).

Acknowledgements

We are much indebted to the original observers who collected the extensive data used here as well as the thousands of volunteers who have contributed to transcribing the data into our database. The North American Bird Phenology Program relies heavily on the work of volunteers around the globe and we could not accomplish what we have without them. There are many individuals besides the authors of this article who have provided guidance and support to the BPP, including Chandler Robbins, Jane Fallon, John R. Sauer, Kevin Laurent, Kinard Boone and Lynda Garrett. The development of the North American Bird Phenology Program has been supported with grants from the National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service, the United States Geological Survey and the Maryland Ornithological Society. We also thank Clemson University with additional support from a Carolina Bird Club grant, for funding the work presented in the hummingbird case study.

Objective:

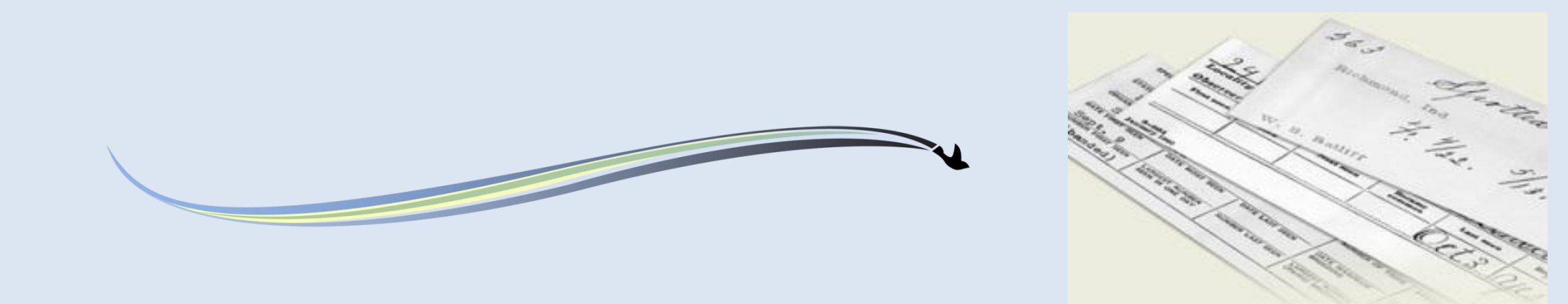
- To demonstrate how historical data from the North American Bird Phenology Program (BPP) can be analyzed for mean arrival date by decade to understand possible changes in migration patterns of Purple martins.

Methods:

- Based on a sample dataset of 5,345 Purple Martin arrival records provided by the BPP, arrival dates were aggregated over each decade, from the 1880's through the 1950's.
- Change point analysis of the mean arrival dates were conducted for latitudinal degree groups (total of 15 groups) in the 1880's-1950's.
- The groups were assigned so each group had data from each decade.

Results and Discussion:

- We found that the arrival dates for 1920's, 1930's and 1940's were statistically earlier than the arrival dates for the 1880's through 1910's (Figure 3).
- A randomized block analysis of variance (ANOVA) of the arrival dates using "decade" as the main effect and "latitudinal band" as the blocking effect showed the main effect (decade) to be statistically significant at 0.05 level (P < 0.0001).
- For all time series and latitudinal groups, the most probable change points selected were the 1890's and 1900's. In most cases, there was a decline in the mean arrival dates after the 1900's.
- Reforestation in the northeast during the beginning of the 20th century and increasing use of artificial martin houses may have increased martin populations during this time, and may partially explain migratory advancements noted.
- Increased competition for nest cavities with introduced species, such as European Starlings (*Sturnus vulgaris*) and House Sparrows (*Passer domesticus*), may also be associated with advancing martin migration dates.



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